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ABSTRACT

A discussion of second language learning through science content focuses on English-as-a-Second-Language (ESL) learning at the elementary and secondary levels. Principles for integrating language and content instruction are identified, and the benefits of the language-across-the-curriculum approach for ESL learners are examined as they relate to those principles. Strategies for developing the science curriculum and instructional materials for this purpose are outlined, including the building of background information, development of vocabulary, addressing specific language functions (describing, predicting, comparing, explaining, giving ordered instructions), teaching language registers, text layout, and discourse structure. Contains 12 references. (MSE)

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LANGUAGE ACROSS THE CURRICULUM:

THE LANGUAGE LEARNING POTENTIAL IN A SCIENCE TEXT

ELAINE W. VINE

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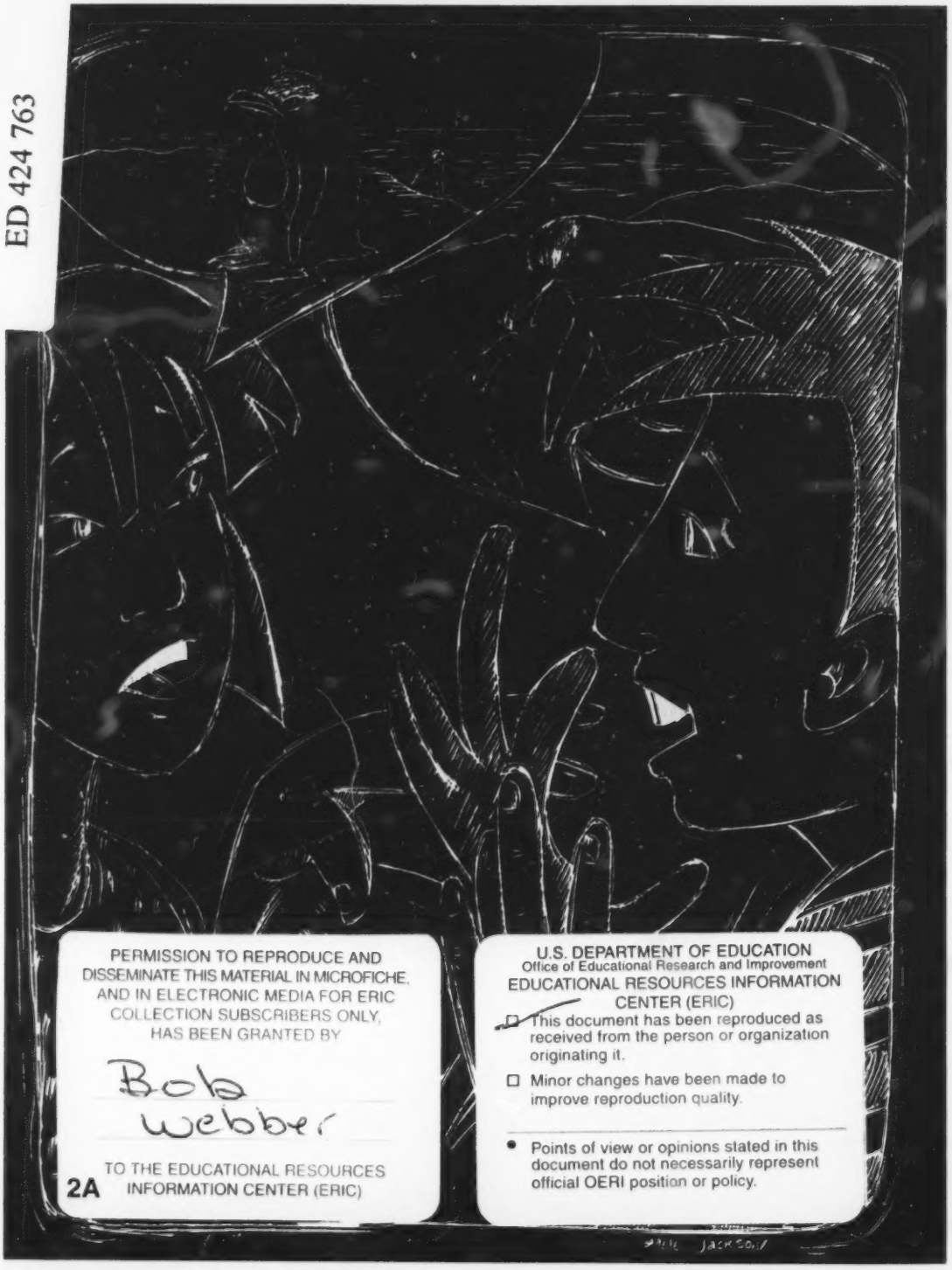

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NEW ZEALAND COUNCIL FOR EDUCATIONAL RESEACH
AUSTRALIAN COUNCIL FOR EDUCATIONAL RESEARCH
WELLINGTON ● MELBOURNE
1997

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So who gets the fish?

Many children in our schools are learning English as a second language (ESL). Naila is one of them. She faces the twin challenges of learning a second language and learning curriculum content at the same time, as we can see in the following incident where Naila is reading a book which involves science content relevant to a current study theme in her class.

Hoiho's Chicks by Joy Cowley is one of the "early readers" used in New Zealand classrooms. It has a simple text, accompanied by photographs:

> Hoiho's chicks are hungry.
> But where is Hoiho?
> He has gone down to the sea to catch fish.
> Hoiho comes out of the sea to feed his chicks.
> But where is the fish?
> It is in Hoiho's gullet.

Photographs by Dean Schneider, reprinted from *Hoiho's Chicks*, by Joy Cowley, 1994, with permission of the publishers, Learning Media, Wellington.

The photograph with the final line of text shows a penguin chick feeding from an adult's gullet (*see* below). Naila read aloud the text of the book accurately. When I asked what "gullet" meant, she said "his throat". However, further discussion revealed that she did not know how the chicks got food, in spite of the picture. She thought the penguin was going away to catch more fish because he had swallowed the last lot!

In terms of science learning, Naila has missed a central point of information from this reading experience. She can read the text aloud, and she has learned the meanings of the words in it, but she has not understood how penguin chicks feed. For Naila, "in his gullet" means that he has swallowed the fish and it is passing through his gullet on its way to his digestive system. She does not realise the possibility that food can be held in the gullet for later retrieval. Naila needs to be learning both language and science from this experience. She has not fully understood the language if she has not understood the science, and vice versa. The language and science learnings are interdependent.

Language across the curriculum

Integrating the learning of language and curriculum content is the focus of a "language across the curriculum" approach, for which three principles have been identified:

- Language develops primarily through its purposeful use.
- Learning often involves and occurs through talking and writing.
- Language use contributes to cognitive development.

There is no language across the curriculum viewpoint in "The Principles" of *The New Zealand Curriculum Framework* (1993). However, under "Language and Languages" in "The Essential Learning Areas" section of the document, there is this statement:

> Language development is essential to intellectual growth. It enables us to make sense of the world around us. The ability to use spoken and written language effectively, to read and to listen, and to discern critically messages from television, film, the computer, and other visual media is fundamental both to learning and to effective participation in society and the workforce. (p. 10)

The "Language and Languages" section links directly to the English and Te Reo Maori curriculum documents, which dilutes the strength of the statement. It should have been included in "The Principles" and thus apply across the curriculum.

The Framework focuses on language as communication by including "Communication Skills" as an "Essential Skill". The link between language and thinking and learning is at best implicit, and at worst lost. Language in our curriculum should be seen not just as the means by which we *communicate* what we are doing, but also as the means by which we *develop* our thinking and learning.

In *Science in the New Zealand Curriculum* (1993) there is no mention of language (either in its communication or cognitive development role) in the "General aims of science education" section. Yet the science curriculum is in fact a language-based one.

Penton (1996) presents an analysis of "the language content and perspectives in the achievement objectives, the possible learning experiences, and the assessment examples" of the New Zealand national science curriculum statement. She finds extensive language expectations throughout the document, both explicit, for example, "listening", "discussing", "interviewing", "reading", "writing", "reporting", and implicit, for example, "information-gathering", "researching". She concludes from her analysis that:

> ... science teachers, like all teachers, are indeed language teachers. Their students will need to effectively use a wide range of language skills as they learn in science. Teachers cannot assume that their students have these essential skills and must therefore know how to judge their competence in these areas, and, when necessary, teach them the skills.

What Penton is advocating here is a language across the curriculum approach.

How can ESL learners benefit from the language across the curriculum approach?

Conversational and academic situations

It is important for ESL learners to learn to cope effectively with the English they need to participate in social, conversational situations, and in academic situations. Specialist ESL classes sometimes focus more on the social, conversational, communicative aspects of English language development than on the academic ones. A language across the curriculum approach can help ensure that ESL learners are supported as they develop the proficiency to participate effectively in both types of situation.

Length of time

Learning a language takes a long time. Studies in the United States and Canada indicate that while immigrant children can develop appropriate conversational skills in two years or so, they can take from four to nine

years to reach normal native-English-speaking levels of academic English proficiency. A language across the curriculum approach also allows for more time to be devoted to language learning than is possible in timetabled English language sessions, and it can support language learning over the long period needed to develop proficiency in using English in academic situations.

Clear purpose

In a language across the curriculum approach, the curriculum content gives ESL learners a clear purpose for learning English. They recognise the value to them of being able to do science, maths, social studies, etc., in terms of their ongoing school life and their life afterwards. They are not just learning English for its own sake, they have a purpose for learning English, which provides a motivation to learn and use the language.

Real-life situations

A language across the curriculum approach gives a "real-life" integration of language and content, which becomes obvious to students. They can see what English is doing for them, as they learn their content material, and they can make more sense of their content material as they learn English to support their content learning. The approach facilitates continued cognitive development while language learning occurs.

Different curriculum contexts

It also provides for teaching and learning the language registers of particular curriculum areas. English is used differently in different curriculum contexts. Students need to learn how to use language effectively to do science, or maths, or any other subject.

Mainstream classes

A language across the curriculum approach allows for placing ESL learners in mainstream classes, rather than in separate classes, or in a low stream. If ESL learners are separated out from the mainstream the potential for them to learn from their peers, intentionally or unintentionally, is lost. Also, the opportunity to teach each other is

taken away from both groups. English speakers can learn a lot about their language by trying to help an ESL learner deal with it. ESL learners can contribute insights into language in particular, but often into other areas of the curriculum as well, in that they have experiences and knowledge that their native-English-speaking peers may not have.

Oral, written, and visual language

A language across the curriculum approach allows for meaningful integration of all three strands of the English curriculum—oral language, written language, and visual language. Content from curriculum areas provides a focus so those strands can be brought together—students can talk about something and write a report about it, or read about something and explain it to someone else, then present a display about it.

How can a language across the curriculum approach be made effective for ESL learners?

Sometimes teachers claim to be taking a language across the curriculum approach, when what they actually have is a curriculum approach. They are simply implementing a curriculum (for instance, science or maths) and the language somehow happens along the way. To a certain extent, of course, it does, but it is possible to plan for more effective language learning to occur within any curriculum area.

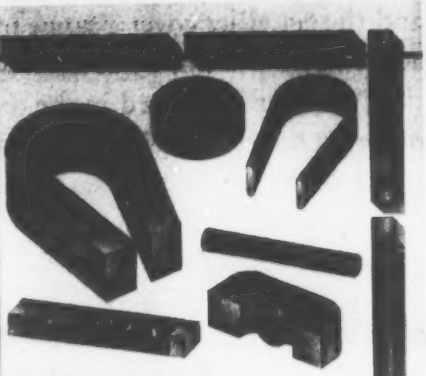
To be effective, language across the curriculum must mean more than just dropping ESL students into the mainstream curriculum. One approach teachers take is to look at the curriculum materials that students will be faced with and identify the language demands of the materials. Then they design teaching-learning activities which focus on relevant aspects of those language demands so as to support the ESL students as they deal with both the language and the content of the curriculum.

Let us take one page of text from a science activity book (*see* opposite) and work through it to see what can be done. The language demands

Magic Magnets

More than 2000 years ago, the Ancient Greeks discovered a strange rock which could attract pieces of iron. Nearly 1000 years later, Chinese sailors used a piece of the same kind of rock to make a simple compass for their ships. If they hung the rock from a thread, they found that it always pointed North and South.

Nowadays, one name for this rock is **lodestone**, which means 'the stone that leads'. Another name is **magnetite**, which comes from the area of Magnesia, where the rock was first discovered. Materials with the same properties as magnetite can be made into **magnets**.



Looking at Magnets

Most modern magnets are made from iron or steel. Some are long and straight; they are called bar magnets. Others are shaped like a horseshoe. Small pieces of metal called **keepers** help to stop horseshoe magnets losing their magnetic force when they are not being used.

Magnetic Attraction

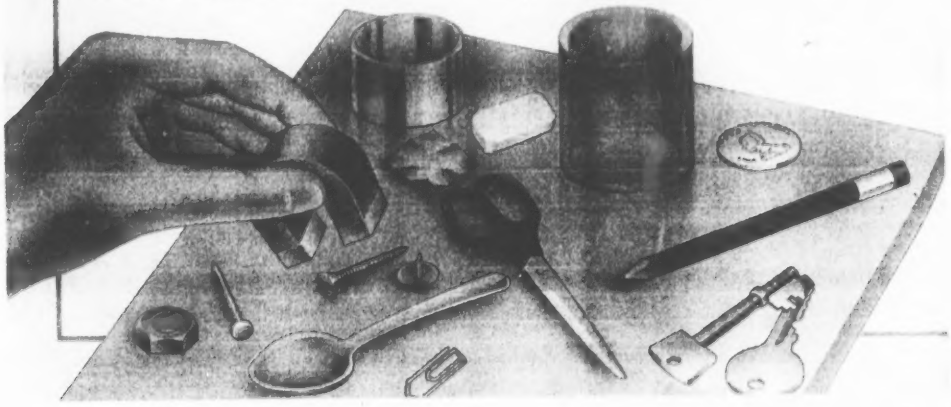
All you need is a magnet and a collection of things to test, such as a metal spoon, a glass jar, a plastic pot, keys, tin foil, coins, paper clips, an eraser, nuts and bolts, needles and pins, small stones and a pencil.

Try this experiment to see which materials are attracted to a magnet.

Touch the end of your magnet to each of the objects in your collection. Some of them will seem to stick to the end of the magnet as if they are glued there. Now try moving the magnet slowly towards each object and watch carefully. Small things will seem to leap towards the magnet. Put all the things that stick to the magnet in a separate pile. What are they made from?

More things to try

Does a magnet attract objects along its whole length or just at the ends?



Page from: *Fun with science—electricity and magnets* by Terry Cash, reprinted with kind permission of the publishers, Kingfisher. **Copyright © Grisewood & Dempsey 1989.**

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and the activities cover a range of English proficiency levels. Thus the activities would not all be used with one group of students, nor would they necessarily be used in the order they are discussed here. Choice and ordering of activities in a given class would depend on the needs of the students in that class. What is demonstrated here is a way of addressing the language learning potential of curriculum materials, using teaching strategies that will be familiar to most teachers.

Background building

Before students meet any new written text for the first time, it is sensible for the teacher to find out what the students already know about the topic, and what language they already have to talk about it. A well-known way to achieve that is to brainstorm the topic. Do the students know what a magnet is? If not, show them. Then get them to talk about what they know about magnets and write key words on the board. The brainstorm can be developed further by using it as the basis for a semantic map. Students organise the brainstorm words into groups, and then draw links between them. The map can be developed further by writing labels on the links to show the nature of the connections.

LANGUAGE DEMANDS	LANGUAGE TEACHING-LEARNING ACTIVITIES
Previous experience with and background knowledge of the topic.	OBJECTIVE: activate and identify students' existing knowledge and vocabulary about magnets. Brainstorm about magnets. Build a semantic map based on the brainstorm.

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This not only allows the teacher to check what the students already know and can say about the topic, but it also has the effect for the students of activating their existing knowledge and reminding them of previous experience—sometimes referred to as "background building".

Vocabulary

If there are students who are not very advanced learners of English, learning or revising very simple vocabulary items will be important if they are going to be able to talk about what they are doing.

LANGUAGE DEMANDS	LANGUAGE TEACHING-LEARNING ACTIVITIES
objects—spoon, jar, pot, key, coin, clip, nuts and bolts, pin, pencil, eraser, etc.	OBJECTIVE: learn and revise names of objects Do the magnetic attraction task from the science text, presenting the name of each object as it is used. Make two lists—objects that stick to the magnet, and ones that do not.

It is important not just to teach the names of the objects, but to teach the word *objects* as well, so that the students have the word they need to talk about the category as a whole.

The students can have opportunities to practise the new vocabulary items through naming the objects as they repeat the activity with a series of different magnets. They can have further practice through repeating the activity to observe any differences that occur when they touch the magnet to objects and when they move it slowly towards the objects, as suggested in the page from the activity book shown on page 11.

Function—describing

The science text asks what the things that stick to the magnet are made from. This introduces a new set of language demands—vocabulary items for materials the objects are made from. An advantage of integrating the language programme into the curriculum is that different levels of language learning can be catered for. A beginner in English can participate in the science activity immediately and learn some vocabulary items. A more advanced learner can move beyond learning vocabulary, through an activity such as a concentration game.

LANGUAGE DEMANDS	LANGUAGE TEACHING-LEARNING ACTIVITIES
materials—glass, metal, paper, rubber, plastic, stone, wood	OBJECTIVE: identify and describe what *materials* particular *objects* are made of.
A jar is made of glass. *A coin is not made of glass.* *A key is made of metal.* *An eraser is not made of metal.* *A pencil is made of wood.*	Concentration game—a set of cards with *object* words and a second set of cards (in a different colour) with *material* words. Turn over one of each and make an appropriate sentence. If you get a match, keep the cards, if not, turn them back.

In terms of science content, the purpose of the concentration game is to match objects with what they are made of. In terms of cognitive processes, the purpose is to use spatial clues (the position of each card) and content clues (what is on each card) to retrieve matching items. The game can also have a language-learning purpose.

The two sets of different coloured cards are mixed together and spread out on the table or floor face downwards. Each player takes a turn to choose two cards, one of each colour, and turn them over. This game can be played without talking, but to make it into a language support

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activity, one of the rules of the game is that players must explain what they have turned over, for example, *A pencil is made of wood* (keep the cards because they match) or *A jar is not made of metal* (turn the cards back in the same place). The game is called *concentration* because the next players try to remember the position of the cards in order to get a match.

A game like this can be a stress-free way of learning. The outcome of the game depends on turning over matching cards. If students make errors either in content (thinking jars are made of metal) or language (not remembering the word for an item), they can be helped by other students or the teacher and there are no consequences apart from the positive one of some learning occurring.

It is possible to add (or avoid) other teaching points in such an activity. For example, in preparing the material the teacher can choose whether or not to introduce *a glass* as an object and *glass* as a material or *a rubber* as an object and *rubber* as a material, thus raising the issue of count and uncount nouns and the use of articles with them.

Functions—predicting, comparing, and explaining

In this science material, there is also potential for more complex sentences that perform various functions in the language. Teachers can use their own creativity to see the potential in the curriculum content and match it up with aspects of language their students are ready to learn or need to practise. For example, the magnetic attraction task, taking a magnet and trying it out on different materials, can be the focus for a range of language functions.

When teachers think about comparing as a language function, they sometimes think only of *more* and *-er* words, but the word *but* can be a signal for comparison also. When students do the magnetic attraction task, they can choose two objects, make a **comparing** sentence using *but* which **predicts** what *will* happen, test the objects with the magnet, then make another **comparing** sentence which **explains** what they observed with a *because* clause.

LANGUAGE DEMANDS	LANGUAGE TEACHING-LEARNING ACTIVITIES
The paper clip will stick to the magnet, but the pencil won't. *The paper clip stuck to the magnet, because it contains iron, but the pencil didn't because it is made of wood.* *The key and the coin stuck to the magnet because they both contain iron.*	OBJECTIVE: learn and practise sentences which predict, compare, and explain Students do the magnetic attraction task from the science text, two objects at a time, making comparative predictions first, and reporting on observations and explaining them afterwards.

This activity should be done after the students have had an opportunity to work freely with the materials and explore what happens. Once they have done that, language demands can be added to the task. Of course, having explored the materials already increases the chances of success on the task because their predictions are likely to be accurate, and the fact that they are familiar with the content means that they are able to focus their attention on the demands of the language part of the task.

An activity like this can also be used to practise listening as well as speaking skills. For example, one student can make a prediction, a second student can implement it, and a third student can report and explain. The students are then understanding and using the sentence patterns in functional contexts.

Function—giving an ordered set of instructions

Another example of using a language function as a language focus would be giving an ordered set of instructions. The science text we are considering ends with a section headed "More things to try" which

contains the question "Does a magnet attract objects along its whole length or just at the ends?" The question sits at the end of the page without explanation. Students have to figure out for themselves that it means they have to design an experiment. The question is not an invitation to guess an answer. It requires them to work out an experiment that will provide evidence to support an answer to that question. So, their first task could be to work out a set of instructions for how to do that.

LANGUAGE DEMANDS	LANGUAGE TEACHING-LEARNING ACTIVITIES
First, collect a set of small objects made of different materials and a set of different magnets. Next, touch each magnet to each object several times at different places on the magnet. Observe what happens and make notes about what you observe.	OBJECTIVE: practise giving an ordered set of instructions. Write a set of instructions for an experiment to answer the question at the end of the page.

The above table gives the sort of language that might be expected from a reasonably advanced group of learners, though this task could be done at a variety of levels. For example, less advanced learners might be expected to produce the following: *First, get some things. Second, touch each thing with a magnet. Touch it with the end of the magnet. Touch it with the middle.*

Language register

A language across the curriculum approach provides for teaching and learning the language registers of particular curriculum areas. One example from our science text is the use of the word *property*, which has an everyday meaning and a science meaning.

LANGUAGE DEMANDS	LANGUAGE TEACHING-LEARNING ACTIVITIES
everyday meanings • *property* and science meanings • *property/properties*	OBJECTIVE: learn everyday and science meanings of the word *property*. Collect examples of the everyday meaning of *property*—things or something that belongs to you—as in *lost property*. Discuss what *properties* might mean in the magnets text—the ways a substance or object behaves in particular conditions. Build up a list of the ways in which magnets behave in different situations to show what are the *properties* of magnets.

There is also a grammatical issue to be addressed here. Property, in the everyday sense of belongings, is an uncount (or uncountable) noun. It does not have a plural form. We can say "my property" (meaning "my belongings") and "our property", but not "our properties" (meaning "our belongings"). However, in the science sense of the ways in which a substance behaves, property is a count (or countable) noun. It can have both singular and plural forms: "a property of iron is..." and "some properties of iron are...". So in dealing with a word like this you would need to address not just the meaning of the word but also aspects of grammar that affect that word.

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Layout of text

When written texts are being considered, another aspect of a text that makes demands on the reader is its layout. This science text is organised into framed sections and columns. A reader needs to know which parts of the text go with which other parts and which are relatively independent. This is not always immediately obvious to students. But there are cues on the page that can help readers. Layout, and the cues it provides, is an issue that can usefully be addressed directly with learners.

LANGUAGE DEMANDS	LANGUAGE TEACHING-LEARNING ACTIVITIES
Use of frames, headings and columns. Relationships between illustrations and sections of text.	OBJECTIVE: learn to identify cues which will help interpret the layout of a text. Show the page on the OHP with the focus blurred. Ask students what they would read first, next, etc. and why. Note features like frames enclosing text, columns, illustrations.

The very first time students see the page from the science activity book shown on page 11, it can be shown on an overhead projector (OHP) with the focus blurred so that they have to use layout cues rather than word cues to help them figure out how it is organised.

There are headings, framing, and columns. Readers have to understand that the frames override the columns, or they may try to go from "Some of them will..." at the bottom of the left-hand column to "Looking at Magnets" at the top of the right-hand column, with a consequent breakdown in sense.

If readers realise that when text is placed within a frame it usually indicates that the text is relatively self-contained, then they will realise that they can choose the order in which they read the three main sections of this page. They may, for example, choose to read first the section of the page that has the most illustrations to support their reading of the text.

Discourse structure

Having considered the physical layout of the text, and noticed that it has three main sections, it is then possible to examine the discourse structure of this page of science material. The sections of text have been separated off for a reason. Each section of the text has a different purpose. The two framed sections at the top of the page have information-giving texts, but even those are different. On the lefthand side is historical background about magnets and how people found out about them. On the righthand side is physical description of the magnets, and at the bottom of the page is explanation of tasks. The language use is very different in those three sections, and some attention can be paid to that.

LANGUAGE DEMANDS	LANGUAGE TEACHING-LEARNING ACTIVITIES
Information-giving sentences in framed sections at top of page—historical background on left, physical description on right. Bottom of page, explanation of tasks —change to *you*, imperatives, and questions.	OBJECTIVE: read and understand informational text, and explain it to another person. Jigsaw activity • Half class is given the "Magic Magnets" section of the text and the other half is given "Looking at Magnets". Each group becomes expert on their text, by discussing it until they're sure they understand it. • In pairs (one from each group) they explain what they have learned to each other (without reference to the text itself, though they may use notes they have taken). • Each pair decides what sort of information is in each of the two texts. • Then each pair is given the "Magnetic Attraction"section and they decide what sort of text it is and how it differs from the two they already had.

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What is important when students are working with the written text from the science book is that their understanding of the text is supported by their experience and their discussion of the content of the science material. They also have opportunities to express what they know and what they have observed and read. This allows for them to learn and practise the language they need to achieve that, which is important from an ESL learner's perspective. It has also been argued that using language in this way supports and extends all students' cognitive development.

Pulling it all together

Students can be given an opportunity to review what they have learned, both in terms of science curriculum content, and in terms of language use, through an activity which encourages them to "pull it all together".

LANGUAGE DEMANDS	LANGUAGE TEACHING-LEARNING ACTIVITIES
Review of the topic and articulating what has been learned	OBJECTIVE: review content and language learned in work on magnets. Make individual books or a class book about magnets.

Making a book involves using spoken language (planning and discussing the process and the content of the book), written language (recording information in the book), and visual language (presenting the material) in an integrated way. It allows students to show what they have learned in terms of science content, and the task can be done at a range of language proficiency levels from single-word labelling of illustrations, to simple descriptive sentences, to extended and more complex text.

Twin challenges

Curriculum content can provide a source of interest and motivation to learn for students, but the content must be made accessible to them through experiences, and they must also be given access to the means of recording and explaining what they are learning both for themselves and to others, and for that they need language. As teachers, we need to ensure that students are given appropriate support to learn both the curriculum content and the language they need to engage with it effectively. We need to move beyond leaving the language to take care of itself.

This book has focused on how the language demands of curriculum materials can be identified and how activities to support language learning based on those demands can be developed. All teachers have a responsibility to ensure that the ESL learners in their classes are supported as they face the twin challenges of learning curriculum content and learning the language of instruction at the same time.

Notes

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Some of the ideas presented here were contributed by teachers enrolled in the DipTESL programme at Victoria University of Wellington. They were enrolled in my "English through the curriculum" course and I would like to acknowledge their contributions.

An earlier version of this work was first presented as:

Vine, E. (1995, August). *Language across the curriculum: The language learning potential in a science text.* Paper presented at WATESOL Expo 1995, Wellington Polytechnic.

The* Hoiho's Chicks *quote is from:

Cowley, J. (photographs by D. Schneider). (1994). *Hoiho's chicks* (Ready to Read series). Wellington: Learning Media.

The three principles of language across the curriculum were identified in:

Corson, D. (1988). *Oral language across the curriculum.* Clevedon, Avon: Multilingual Matters

The official documents referred to are:

New Zealand Ministry of Education. (1993). *Science in the New Zealand curriculum.* Wellington: Learning Media.

New Zealand Ministry of Education. (1993). *The New Zealand curriculum framework.* Wellington: Learning Media.

New Zealand Ministry of Education. (1994). *English in the New Zealand curriculum.* Wellington: Learning Media.

The analysis of the national science curriculum statement is on page 8 of:

Penton, R. (1996). Analysis of the language content and perspectives in the national curriculum statements. *Many Voices: A Journal of New Settlers and Multicultural Education Issues, 9,* 4–10.

The benefits for ESL learners of conversational situations, and of the learning across the curriculum approach, are reported by:

Cummins, J. (1994). The acquisition of English as a second language. In K. Spangenberg-Urbschat & R. Pritchard (Eds.), *Kids come in all languages: Reading instruction for ESL students* (pp. 36–62). Newark, Delaware: International Reading Association.

Cummins, J. (1994). Knowledge, power, and identity in teaching English as a second language. In F. Genesee (Ed.), *Educating second language children: The whole child, the whole curriculum, the whole community* (pp. 33–58). Cambridge: Cambridge University Press.

Studies showing it can take four to nine years for immigrant children to reach native-English-speaking levels of proficiency include:

Collier, V. P. (1987). Age and rate of acquisition of second language for academic purposes. *TESOL Quarterly, 21,* 617–641.

Cummins, J. (1981). Age on arrival and immigrant second language learning in Canada: A reassessment. *Applied Linguistics, 2,* 132–149.

"Background building" is referred to in:

Reyes, M., & Molner, L. (1991) Instructional strategies for second-language learners in the content areas. *Journal of Reading, 35*(2), 96–103.

That using language constructively extends students' cognitive development is argued by:

Corson (1988), *see* above.

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